Sequencing to Station in 12 months (targeting Orbital 5 launch, March 30th)

The Class 1E Process

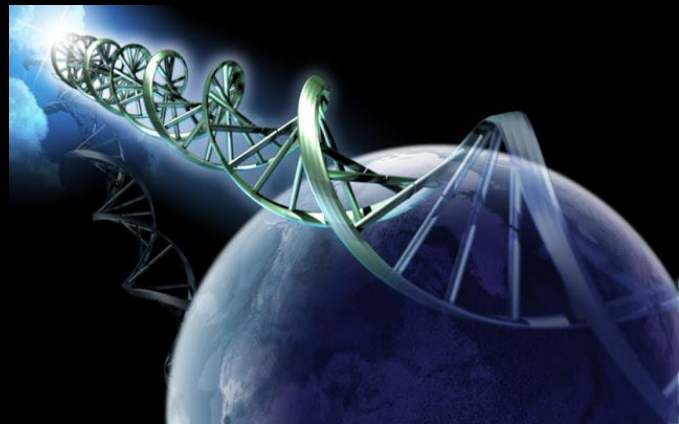
- Science to Station more quickly
- New class of hardware to be called Experiment Flight Hardware, or Class 1-E
  - "Don't hurt the crew"
  - "Don't hurt the station"
- Tech demo, payload, and hardware on the space station

Class 1E Implementation

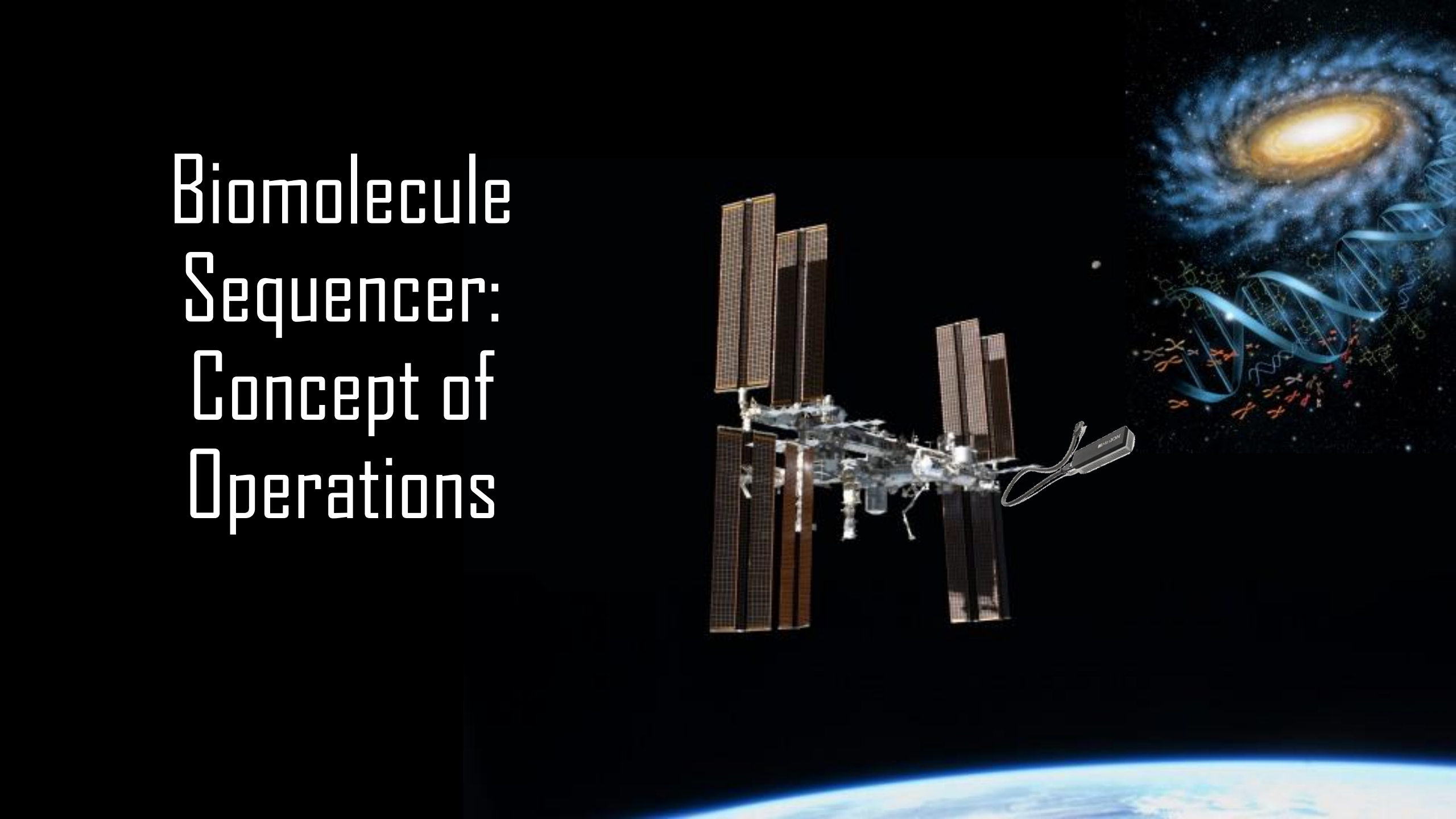
- MinION is a technology demonstration project
- Primary Objective: Test a small COTS DNA sequencer in microgravity on ISS
- Secondary Objectives
  - Test, refine and report on the use of the Class 1E process
  - Form a partnership of engineers and scientists using the ISS as an exploration laboratory
  - Future opportunities for MinION/sequencing

DNA Sequencing: Benefits

- Benefits to In-flight Sequencing
  - Sequencing on the ISS can inform real-time decisions (research, med ops, etc.)
  - Unlike other technologies, sequencing is not limited to the detection of targets, but rather will provide data on the entirety of a sample
  - Reduce down mass (sample return for environmental monitoring, crew health, etc.)
  - Real-time analysis can influence medical intervention
  - Support in-situ science investigations
  - Technology superiorly suited to astrobiology / search for life investigations



Biomolecule Sequencer: Concept of Operations

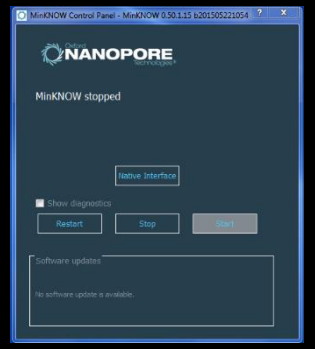


4. Destow and connect MinION to Surface Pro3

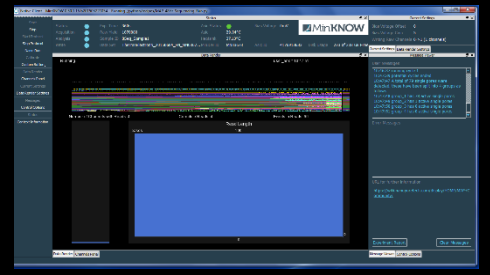
5. Sample injection

6. Dispose of sample syringe

7. Initiate the sequencing experiment



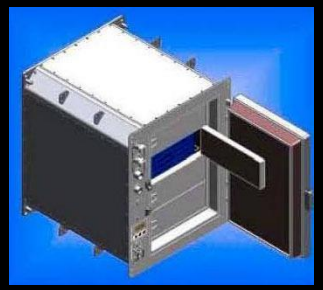
8. Data collection

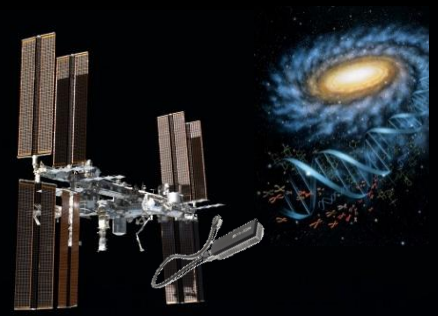


Sequencing stops after 48 hrs

3. Remove flow cells and sample syringes from cold stowage and allow to equilibrate to room temperature

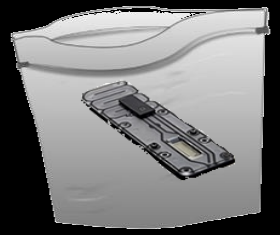
2. Stowage
(Ambient, -90°C, + 4°C)





The first DNA Sequencer in Space!

9. Stow used flow cell for return



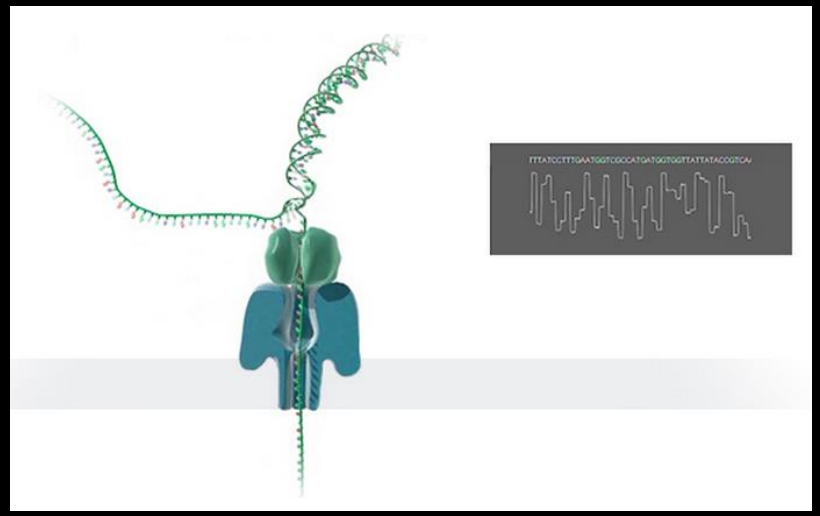
10. Data downlink

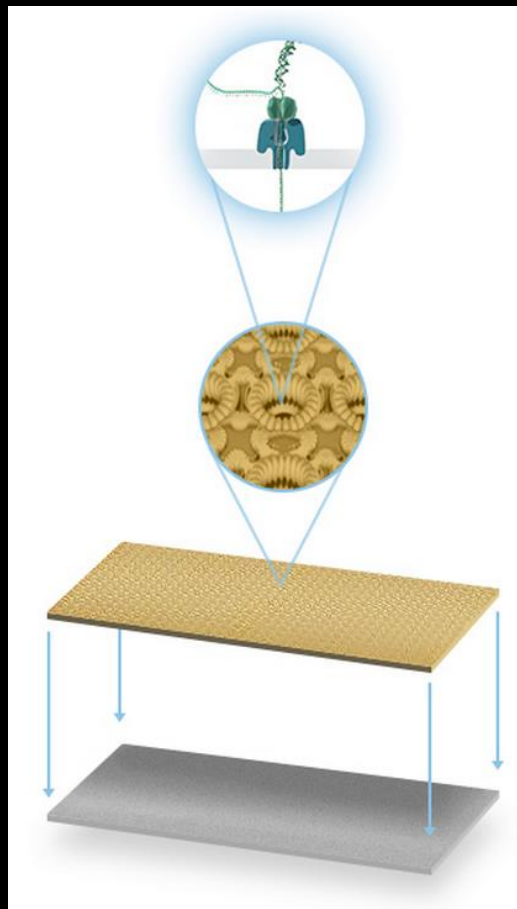
1. Launch packaged items

11. Stow MinION, Surface Pro3 and associated power & USB cords

12. Return of payload

Nanopore sequencing





Nanopore

A protein nanopore is set in an electrically resistant polymer membrane. An ionic current is passed through the nanopore by setting a voltage across this membrane. If an analyte passes through the pore or near its aperture, this event creates a characteristic disruption in current. Measurement of that current makes it possible to identify the molecule in question. For example, this system can be used to distinguish between the four standard DNA bases G, A, T and C, and also modified bases.

Array of Microscaffolds

An array of microscaffolds holds the membrane in which the nanopore embedded. This keeps the membrane stable during shipping and usage.

Array Chip

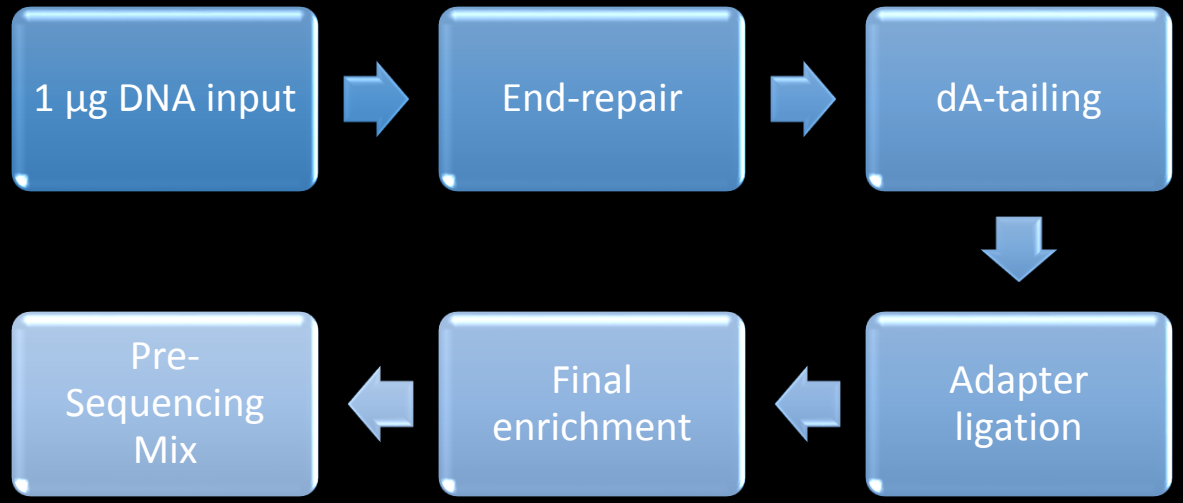
Each microscaffold on the sensor array chip contains an individual electrode, allowing for multiple nanopore experiments to be performed in parallel. Sensor arrays may be manufactured with any number of channels.

ASIC

Each nanopore channel is controlled and measured by an individual channel on a corresponding, bespoke Application Specific Integrated Circuit (ASIC). More than one ASIC may be included in a device and Oxford Nanopore is building ASICs of different sizes for different purposes.

MinION Sample Prep Workflow

- Prep time ~4 hours
- Requires molecular biology laboratory and trained personnel
- Loading of flow cell ~30 minutes with multiple pipetting steps
- Manual preparation of DNA not currently feasible in microgravity



Sample to be sequenced

- Virus – lambda bacteriophage
- Bacterium – *E. coli* genomic DNA
- Mammal – Mouse genomic DNA

Forward work and opportunities for collaboration

- Biomolecule Sequencer is a tech demonstration on ground-prepared samples
- Have a need or potential need for in-flight:
  - DNA extraction
  - DNA amplification
  - Sequencing library preparation
  - Researchers with projects that require or could benefit sequencing